# Is intake of fruits and vegetables related to adiposity in children?

## Conclusion

A limited body of evidence from longitudinal studies suggests that greater intake of fruits and/or vegetables may protect against increased adiposity in children and adolescents.

## Grade: Limited

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

## Evidence Summary Overview

The conclusion that increased fruit and vegetable intake may protect against increased adiposity in children when consumed as part of a nutrient-rich, energy-balanced diet is based on a full Nutrition Evidence Library (NEL) literature search, supplemented by the findings of prospective studies included in an earlier evidence review conducted by the American Dietetic Association (ADA) (1982 to 2004). Collectively, the evidence review led to the conclusion that increased intake of fruits and vegetables may be associated with reduced adiposity in children. In combination, the two systematic literature searches identified seven randomized controlled trials (RCT) or longitudinal studies that addressed the research question and met other inclusion criteria. This included one RCT (Epstein, 2008) and six longitudinal studies of five cohorts (Faith, 2006; Field, 2003; Newby, 2003; Newby, 2004; Sugimori, 2004; Wang, 2003). Five studies were conducted in the US, one in Japan and one in China. Overall, of the seven included studies, three studies found evidence for an inverse, protective association between dietary intake of fruits and vegetables and adiposity in children, either for the total sample (Epstein, 2008; Wang, 2003), or for a subsample of children, based on gender (Field, 2003). Results from three other cohorts (four reports) found no association between intake of fruits and vegetables and adiposity (Faith, 2006; Newby, 2003; Newby, 2004; Sugimori, 2004).

In summary, results from longitudinal studies and one RCT in general found either a negative, protective association, or no association between increased consumption of vegetables and fruits and adiposity in children. However, interpretation of results and comparison of results across studies is hampered by lack of uniformity as to which vegetables and fruits were included in each respective food group, or whether fruit juice was included in the fruit food group. In addition, none of the studies rigorously assessed or adjusted for implausible energy intake and all used body mass index (BMI) as an estimate of fatness, which has been shown to be a poor measure of adiposity in children. Despite these methodological difficulties, review of the evidence to date provided some support for an inverse (protective) association between increased vegetable and fruit intake and adiposity in children.

## Evidence Summary Paragraphs

### *Randomized Controlled Trials (1)*

**Epstein et al, 2008** (positive quality) conducted an RCT in the US, compared targeting increased

eating of healthy foods vs. reducing intake of high energy-dense foods within the context of a family-based behavioral weight control program. Children and their families were randomized into one of two groups for 24 months: Increase Healthy Foods (fruits, vegetables and low-fat dairy) or Reduce High Energy-Dense Foods (high-fat, high-sugar foods). Both groups were given The Traffic Light Diet to reduce their energy intake, and a similar activity program. Families attended weekly meetings for two months, biweekly meetings for two months and one monthly meeting, followed by meetings for assessment of height and weight at six, 12 and 24 months. Both children and parents recorded their eating in a habit book. Height was measured using a stadiometer and weight was measured on balance-beam scale; BMI and zBMI were calculated. The final sample included 27 (mean age = 10 years). While children in the Reduce High Energy-Dense Foods group showed larger sustained reductions in high energy-dense foods ($P<0.05$), children in the Increase Healthy Foods group showed greater reduction in zBMI compared to children in the Reduce High Energy-Dense Foods group at 12 months (-0.30 zBMI units vs. -0.15 zBMI units, $P=0.01$) and 24 months (-0.36 zBMI units vs. -0.13 zBMI units, $P=0.04$). In addition, parent and child zBMI changes were correlated ($P<0.001$).

***Cohort Studies (6)***

**Faith et al, 2006** (neutral quality) used a prospective cohort design study to test whether increased fruit and vegetable intake and parent parental restriction of children's eating was associated with adiposity in children participating in the Women, Infants and Children (WIC) program in New York. Questionnaires were given to parents attending WIC clinics, which included questions on the usual number of servings per day of fruit and vegetables that the child consumed and parental feeding practices. Each child's most recent height or length, weight and date of measurement were abstracted from his or her WIC chart at the time of the survey. Additional data to compare to baseline were obtained for each study child beginning in December 2001 to September 2002 by abstracting height, weight and measurement data from WIC charts. The final sample included 971 children (53% boys; mean age at baseline = 30 months). Results showed that greater parental offering of fruit was associated with reduced adiposity gain ($P=0.06$). However, actual reported intake of fruits and vegetables was not significantly (NS) associated with adiposity gain. Therefore, children whose parents offered them fruit more frequently were less likely to gain adiposity, but there was no association between actual fruit and vegetable intake and adiposity gain.

**Field et al, 2003** (positive quality) used data from a prospective cohort study to assess whether intake of fruits and vegetables and fruit juice were associated with change in BMI among a large sample of children and adolescents in the US. Participants were ages nine to 14 years in 1996 and completed at least two questionnaires between 1996 and 1999 as part of the Growing Up Today Study (GUTS). Fruit, vegetable and fruit juice intake were assessed with the Youth/Adolescent Questionnaire (YAQ), a self-administered semi-quantitative food frequency questionnaire (FFQ) assessing intake of 131 foods over the past year. Weight status was determined using BMI that was calculated using self-reported height and weight, and was based on age- and gender-specific Centers for Disease Control and Prevention (CDC) growth charts. Results were adjusted for age, Tanner stage, activity, inactivity, age- and gender-specific z-score of BMI at baseline, height change and total energy intake. The final sample included 8,203 girls and 6,715 boys (mean age = 12 years; mean BMI=19kg/$m^2$). Results showed that, on average, girls and boys consumed slightly fewer than two servings of fruit per day, of which almost 50% was in the form of juice, fewer servings of vegetables than fruit per day; about zero to three servings a day were attributed to potatoes, and fewer than 25% of the participants were meeting the recommendation to consume at least five servings of fruits and vegetables per day. There were no significant (NS) associations between intake of fruits, fruit juice or vegetables (alone or combined) and subsequent changes in BMI z-score among girls (adjusted for Tanner stage, age, height change, activity and inactivity). Among boys,

intake of fruit and fruit juice was not predictive of changes in BMI; however, vegetable intake was inversely associated to changes in BMI z-score (β=-0.003). However, this was no longer significant after data was adjusted for total energy intake. After adjusting for total energy intake, fruit intake (β=0.003 for girls and β=0.002 for boys) was predictive of having a slightly larger BMI z-score at the end of the follow-up period.

**Newby, 2003** (positive quality) analyzed prospective cohort data from the US to examine the relationship between diet and weight in children. Subjects were from the North Dakota WIC program and were aged two to five years at baseline. Children included in these analyses had at least two clinic visits, which were about one year apart. Height and weight were measured and BMI was calculated. Dietary data was collected using an FFQ. The final sample included 1,379 children (689 girls, 690 boys; mean age = three years). Results showed a 0.09kg greater weight change (95% CI: 0.05, 0.13kg) for each additional serving of vegetables in multivariate, energy-adjusted models. When all food groups were considered in a single model, the relationship between vegetable intake and weight change was no longer significant. Intake of fruit was NS related to weight change in any of the models tested and this finding remained when fruit juices were excluded from analyses.

**Sugimori, 2004** (neutral quality) used data from a prospective cohort study to elucidate both environmental and behavioral factors that influence BMI among Japanese children from ages three to six. Children were assessed at baseline, age three years, and follow-up for three years to age six. Height and weight were measured and used to determine BMI and weight status, and diet was assessed using a questionnaire. Children were categorized into four groups: Group one, normal at both age three years and six years (normal/normal); group two, overweight at age three years and normal at age six years (overweight/normal); group three, normal at age three years and overweight at age six years (normal/overweight); and group four, overweight at both age three years and six years (overweight/overweight). The final sample included 8,170 subjects (4,176 boys, 3,994 girls; age three years at baseline). There were NS associations found between vegetable or fruit intake and weight change over three years.

**Wang, 2003** (neutral quality) analyzed prospective cohort data from China to evaluate the effects of dietary intake on childhood overweight. Subjects were participants in the China Health and Nutrition Survey who were initially overweight at baseline (1991), and were resurveyed in 1993. Measurements of height and weight were taken to determine BMI, and dietary intake was assessed using three 24-hour recalls. The final sample included 95 children (51 boys, 44 girls; mean age = nine years; 6% were overweight). Children who were overweight at baseline were less likely to be overweight after two years when they consumed a diet higher in vegetables and fruit (RR=0.7, 95% CI: 0.5, 0.9; P<0.05).

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| Author, Year, Study Design, Class, Rating | Participants | Methods | Outcomes |
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| Epstein LH et al 2008<br><br>Study Design: Randomized | N=27.<br><br>Mean age: 10 years.<br><br>Location: | Children and their families randomized into one of two groups for 24 months:<br><br>1) Increase Healthy Foods | While children in the Reduce High Energy-Dense Foods group showed larger sustained ↓ in high energy-dense foods (P<0.05), children in the |

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| Controlled Trial<br><br>Class: A<br><br>Rating: | United States. | (fruits, vegetables and low-fat dairy)<br><br>2) Reduce High Energy-Dense Foods (high-fat, high-sugar foods).<br><br>Assessment of height and weight at six, 12 and 24 months.<br><br>Both children and parents recorded their eating in a habit book. | Increase Healthy Foods group showed greater ↓ in zBMI compared to children in the Reduce High Energy-Dense Foods group at 12 months (-0.30 zBMI units vs. -0.15 zBMI units, P=0.01) and 24 months (-0.36 zBMI units vs. -0.13 zBMI units, P=0.04). |
| Faith MS, Dennison BA et al, 2006<br><br>Study Design: Prospective Cohort Study<br><br>Class: B<br><br>Rating: | N=971 (53% boys).<br><br>Mean age at baseline: 30 months.<br><br>Location: United States. | Questionnaires given to parents attending WIC clinics, which included questions on usual number of servings per day of fruit and vegetables that the child consumed and parental feeding practices.<br><br>Each child's most recent height or length, weight and date of measurement abstracted from his/her WIC chart at time of survey. | Greater parental offering of fruit was associated with ↓ adiposity gain (P=0.06).<br><br>However, actual reported intake of fruits and vegetables was NS associated with adiposity gain.<br><br>Therefore, children whose parents offered them fruit more frequently were ↓ likely to gain adiposity, but no association between actual fruit and vegetable intake and adiposity gain. |
| Field A, Gillman M et al, 2003<br><br>Study Design: Prospective Cohort Study<br><br>Class: B<br><br>Rating: | N=8,203 girls and 6,715 boys.<br><br>Mean age: 12 years (Nine to 14 years at baseline).<br><br>Mean BMI=19kg/$m^2$.<br><br>Location: United States. | Diet assessed using the Youth/Adolescent Questionnaire (YAQ).<br><br>Weight status determined using BMI that was calculated using self-reported height and weight. | NS associations between intake of fruits, fruit juice or vegetables (alone or combined) and subsequent Δ in BMI z-score among girls.<br><br>Among boys, intake of fruit/fruit juice not predictive of Δs in BMI; however, vegetable intake inversely associated to Δs in BMI z-score (β=-0.003). However, NS after data were adjusted for total energy intake.<br><br>After adjusting for total energy intake, fruit intake (β=0.003 for girls and β=0.002 for boys) was |

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| | | | predictive of having a slightly larger BMI z-score at the end of the follow-up period. |
| Newby PK, Peterson KE et al, 2003<br><br>Study Design: Cohort study (longitudinal, prospective)<br><br>Class: B<br><br>Rating:  | N=1,379 (689 girls, 690 boys).<br><br>Mean age: Three years.<br><br>Location: United States. | Children had at least two clinic visits, which were ~one year apart.<br><br>Height and weight measured and BMI calculated.<br><br>Dietary data collected using an FFQ. | 0.09kg greater weight Δ (95% CI: 0.05, 0.13kg) for each additional serving of vegetables in multivariate, energy-adjusted models.<br><br>When all food groups were considered in a single model, relationship between vegetable intake and weight Δ was NS any longer.<br><br>Intake of fruit was NS related to weight Δ in any of the models tested, and this finding remained when fruit juices were excluded from analyses. |
| Sugimori H, Yoshida K et al 2004<br><br>Study Design: Cohort (longitudinal, prospective)<br><br>Class: B<br><br>Rating:  | N=8,170 (4,176 boys, 3,994 girls).<br><br>Age: Three years at baseline. | Children assessed at baseline, age three years and follow-up for three years to age six.<br><br>Height and weight measured and used to determine BMI and weight status; diet assessed using a questionnaire. | NS associations found between vegetable or fruit intake and weight Δ over three years. |
| Wang Y, Ge K, Popkin BM, 2003<br><br>Study Design: Cohort (longitudinal, prospective)<br><br>Class: B | Final N: 95 children (51 boys, 44 girls).<br><br>Mean age: Nine years.<br><br>6% overweight.<br><br>Location: China. | Subjects were initially overweight at baseline (1991) and were resurveyed in 1993.<br><br>Measurements of height and weight taken to determine BMI and dietary intake assessed using three 24-hour recalls. | Children who were overweight at baseline were less likely to be overweight after two years when they consumed a diet higher in vegetables and fruit (RR, 0.7; 95% CI: 0.5, 0.9; P<0.05). |

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| Rating: | | | |

**Research Design and Implementation Rating Summary**
For a summary of the Research Design and Implementation Rating results, click here.

**Worksheets**

Epstein LH, Paluch RA, Beecher MD, Roemmich JN. Increasing healthy eating vs. reducing high energy-dense foods to treat pediatric obesity. *Obesity (Silver Spring).* 2008;16(2):318-26.

Faith MS, Dennison BA, Edmunds LS, Stratton HH. Fruit juice intake predicts increased adiposity gain in children from low-income families: Weight status-by-environment interaction. *Pediatrics.* 2006 Nov; 118 (5): 2,066-2,075.

Field AE, Gillman MW, Rockett HR, Colditz GA. Association between fruit and vegetable intake and change in body mass index among a large sample of children and adolescents in the United States. *Int J Obesity.* 2003; 27: 821-826.

Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Dietary composition and weight change among low-income preschool children. *Arch Pediatr Adolesc Med.* August 2003;157(8):759-64.

Sugimori H, Yoshida K, Izuno T, Miyakawa M, Suka M, Sekine M, Yamagami T, Kagamimori S. Analysis of factors that influence body mass index from ages 3 to 6 years: A study based on the Toyama cohort study. *Pediatr Int.* 2004 Jun;46(3):302-10.

Wang Y, Ge K, Popkin BM. Why do some overweight children remain overweight, whereas others do not? *Public Health Nutr.* 2003 Sep;6(6):549-58.